



Munich Personal RePEc Archive

Islamic equity as an alternative investment from the perspective of the Southeast Asian investors: evidence from MGARCH-DCC and Wavelet Coherence

Suwanhirunkul, Suwijak and Masih, Mansur

INCEIF, Malaysia, INCEIF, Malaysia

26 December 2018

Online at <https://mpra.ub.uni-muenchen.de/93542/>

MPRA Paper No. 93542, posted 01 May 2019 16:42 UTC

Islamic equity as an alternative investment from the perspective of the Southeast Asian investors: evidence from MGARCH-DCC and Wavelet Coherence

Suwijak Suwanhirunkul¹ and Mansur Masih²

Abstracts

International diversification of equity is important for investors who want to reduce risk of capital loss. However, international diversification benefit is inconclusive. This research is the initial attempt to find international diversification benefit of global Islamic equity (in the World, US, EU and Asia Pacific region) from the perspective of the conventional Southeast Asian investors. We use relatively advanced and robust techniques MGARCH-DCC and Wavelet coherence. We find that, for the Southeast Asia as a whole region, very-short-term investors have obvious diversification benefit in Islamic equities in World, Europe and US regions but not in Asia Pacific region. Short-term and Medium-term investors face limited diversification benefit, while long-term investors have benefit in Islamic Europe and US equity. Each Southeast Asian country has varying benefit at different investment horizons. The result of this study provides suggestion for the investors who have different investment horizons to effectively diversify their conventional stocks with Islamic equity.

Keywords: portfolio diversification, Islamic equity, MGARCH-DCC, Wavelet coherence, Southeast Asia

¹Doctoral student in Islamic finance at INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia.

² **Corresponding author**, Professor of Finance and Econometrics, INCEIF, Lorong Universiti A, 59100 Kuala Lumpur, Malaysia. Phone: +60173841464 Email: mansurmasih@gmail.com

1. Introduction

One of the most important principles of investing is to ensure that an investor has a diversified portfolio. This means that the investor spreads his capital amongst different investments so that he is not reliant upon a single investment. Diversification has several benefits. First, it minimises the risk of capital loss to investment portfolio. In addition, diversification preserves capital. Investors who are close to retirement have goals oriented towards preservation of capital, and thus diversification can protect their savings. Moreover, diversification generates higher returns as an investor is not merely relying upon one source of income.

Theoretically, international diversification is important to lower portfolio risks. International diversification benefit is high when there are low correlations across equity markets. On the contrary, diversification benefit is low when there is an increase in co-movements between asset returns of international stocks, lowering the benefit of internationally diversified investment portfolios. International investors and fund managers pay substantial attention to international stock market linkages among different regions to identify a potential mix of international stocks that creates a well-diversified portfolio with lowest possible risk.

However, empirical studies show that international diversification benefit is inconclusive. Agmon (1972) found that there are substantial opportunities for international equity diversification. Achsani et al (2007) supported the evidence of significant diversification benefit in international equity markets. On the other hand, Eun and Shim (1989) demonstrated that diversification benefit is not substantial due to strong correlations across national equity markets. Limited diversification benefit is supported by Aziz and Kurniawan (2007).

Therefore, this paper studies the international diversification benefit of Islamic equity to conventional Southeast Asian equity investors. We explore Islamic equity in a global market (Islamic World) and three regions (Islamic US, EU and Asia Pacific). We investigate conventional Southeast Asian equity (the whole region) and six major countries namely Thailand, Malaysia, Indonesia, Philippines, Singapore, and Vietnam. We used Continuous Wavelet transform to examine different investment horizons.

Studying different investment horizons is important because the diversification benefit is more robust and visible when correlations are sorted by different holding periods across time. Equity market returns are not only time varying but also dependent on time scales or investment horizons. Therefore, different holding periods contribute to different diversification opportunities. However, there are only a few empirical studies investigating diversification benefit in different holding periods. Thus, more empirical research in time scale dimension of portfolio diversification is needed.

Islamic equity is studied due to growing attention from higher global demand of both Muslims and non-Muslims for ethical investment. Islamic equities are stocks screened with Shariah restrictions. One restriction is that finances of the company must have limited interest-based financial transactions. From this, many argue that Islamic equity has the potential diversification advantage due to lower financial risk. However, diversification benefit of Islamic equity is mixed in the literature. Thus, we study Islamic World equity to first observe diversification benefit of Islamic equity globally. We also examine Islamic equity in major regions namely Islamic US, Europe and Asia Pacific.

Conventional Southeast Asia is studied because it is one of the most dynamic areas of the world economically, resulting in its growing international significance. Stock markets in Southeast Asia performed better than other stock markets in the Asia-Pacific region in 2015. We choose to study Thailand, Malaysia, Indonesia, Singapore, Vietnam, and Philippines because they have the largest economies among all Southeast Asian countries.

Our paper has following objectives and contributions. First, since international diversification benefit is inconclusive, we explore diversification benefit of Southeast Asian equity and Islamic equity to provide further evidence of international diversification. Second, since diversification benefit of Islamic equity is mixed, our study will further provide evidence about diversification benefit of Islamic equity. Third, since many previous literature's volatility models did not take in account dynamic correlations between asset returns, we apply more robust technique MGARCH-DCC allowing for dynamic correlations. Moreover, few studies investigate diversification benefit of different investment horizons, we will provide this evidence from advanced technique Wavelet Coherence.

Our main findings are as follow. International diversification benefit exists in Southeast Asian equity and Islamic equity. For conventional Southeast Asian investors, diversification benefit of Islamic equity is more evident in World, US and EU regions while it is more limited

in Asia Pacific. This result also proves that Islamic equity provides substantial diversification benefit to conventional equity. Importantly, diversification benefit varies in different holding periods. For the whole Southeast Asia region, very-short-term investors (less-than-16 days investment horizon) have diversification opportunity in Islamic World, US and EU while Asia Pacific provides the least diversification benefit. In contrast, short-term (16-64 days investment horizon) and medium-term investors (64-256 days investment horizon) have small diversification benefit in all Islamic equity regions. Similar to very-short-term, long-term investors (over 256 days investment horizon) have substantial diversification benefit in Islamic World, US and EU. The benefit is more observable in Europe market.

For each Southeast Asian country, diversification benefit varies among countries in different holding periods. Very-short-term investment in Islamic equity provides diversification benefit in all countries. Specifically, for Singapore, Islamic equity in Asia Pacific provides little benefit in very-short-term. For most countries including Thailand, Malaysia, Singapore, and Philippines, diversification benefit is hardly seen in the short-term and medium-term except for Vietnam and Indonesia. In the long-term, diversification benefit of Islamic World, US and EU is substantial in all countries. Asia Pacific still plays a limited role for diversification. Philippines, Singapore, Indonesia experience highest benefit in Europe and US. For comparison among countries, diversification benefit is very limited in Singapore while it is outstanding in Vietnam. The benefit exists to some extent in Thailand, Malaysia, Indonesia and Philippines.

The paper is organized as follow: Section 2: literature review, Section 3: Data and methodology, Section 4: Empirical result, and Section 5: Conclusion and policy implication

2. Literature review

2.1 International Portfolio Diversification

Diversification is the process of allocating capital in a way that reduces the exposure to any particular asset or risk. A common path towards diversification is to reduce risk or volatility by investing in a variety of assets. If asset prices do not change with perfect correlation, there is a diversification benefit and thus a diversified portfolio will have less variance than the weighted average variance of all its assets.

Portfolio diversification has two main theories: Capital Asset Pricing Model (CAPM) and Modern Portfolio Theory (MPT). These theories advocate that in order to reduce the risk,

individual and institutional investors should hold well-diversified portfolios. In other words, the integration and interdependence of stock markets underlies a major cornerstone of MPT which stresses the issue of diversifying assets. This theory suggests that investors should diversify their assets across national borders, as long as returns to stock in other markets are less than perfectly correlated with the domestic market.

Although the theories suggest that diversification results in higher risk-adjusted return portfolio, the empirical finding of international diversification benefit is still inconclusive. Empirical study by Agmon (1972), using weekly returns data, found no significant linkages amongst the common stocks of Germany, Japan, the UK and the USA and hence the study supports the advantage of international portfolio diversification. Following Agmon (1972), study by Solnik (1974) found evidence in favor of low correlations among cross border stock markets, indicating that there is substantial international diversification benefit.

However, some empirical studies found that international diversification yields insignificant diversification benefit. Becker et al (1990) finds strong correlation between US and Japanese markets, concluding that diversification benefit cannot be observed. In addition, Eun and Shim (1989) examined various stock price indices around the stock market crash of 1987 and found a substantial amount of interdependence among national stock markets. High interdependence result in very limited diversification advantage. Furthermore, Kearney and Lucey (2004) documented that the global economic and financial systems are becoming increasingly integrated because of the fast expansion of international trade in commodities, services and financial assets, concluding that diversification potential is low.

Many researchers have increasing interest in diversification benefit of Islamic equity in many regions and the result is inconclusive. Marashdeh (2005) documented that there was no cointegration between the selected MENA stock markets (Egypt, Jordan, Morocco and Turkey) and that of the major developed economies (the US, UK and Germany). This implies potential diversification benefits for the investors. Bley and Chen (2006) studied the stock markets of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia and the United Arab Emirates, concluding that there is portfolio diversification benefit in many countries but limited in some countries.

Majid, Yusof, and Razal (2007) investigated the degree of cointegration among eight Islamic countries' stock markets, such as Turkey, Egypt, Oman, Kuwait, Malaysia, Indonesia, Bangladesh and Pakistan. The study concluded that the stock markets of Malaysia, Indonesia, Bangladesh and Pakistan are integrated, indicating low diversification benefit. However, the

stock markets in Turkey, Egypt, Oman and Kuwait are not, indicating high potential for diversification.

2.2 Islamic equity investment

Shari'ah is a Divine Law which governs the practical aspect of a Muslim's daily life. In commerce, it can determine business style and indicate a desire to comply with 'halal' (lawful) and ethical investing. Islamic investing is growing rapidly as an alternative investment class for all investors, both Muslim and non-Muslim, for its foundation in ethical business practices, social responsibility and fiscal conservatism. Many non-Muslim investors are interested in Islamic equity due to various benefits such as greater stability of returns, transparency and diversification.

The modern Shari'ah scholars have provided general rules for Islamic investors to evaluate or screen whether a particular company is halal (lawful) or haram (unlawful) for investment. There are two types of stock screening approaches such as qualitative and quantitative screens. The first one is qualitative screen, the screening process that focuses on the activity of a company that is used as the main principle in Islamic investment criteria. The second one is quantitative screen, where Islamic scholars have applied a principle of tolerance associated with filtering criteria, namely:

1. Debt/equity ratio. If a company's debt financing is more than 33 percent of its capital, then it is impermissible for investment.
2. Interest-related income. If interest-related income of a company is more than 10 percent of its total income, then it is not permissible for investment.
3. Monetary assets. This parameter refers to the composition of account receivables and liquid assets (cash at banks and marketable securities) compared to total assets. Some set this minimum at 51 percent while a few cite 33 percent as an acceptable ratio of non-liquid assets to total assets.

Due to the ethical foundations of Islamic stock indices, some argue (Iqbal, Mirakhor, Krichenne, and Askari, 2010) that Islamic stock indices provide better diversification benefits compared with their conventional counterparts. This is because the limit of interest-based leverage would lead to lower systemic risks of Islamic stocks indices, both during expansion and recession. In addition, the leverage limit may lead the performance of individual firms to be less influenced by interest rate movement and would not fluctuate in the same fashion as

overall markets. This conform to the study of Iqbal et al. (2010) who argued about the lower correlation of individual stock price with other assets as well as the whole market.

However, it is argued that ethical investing will under-perform over the long-term horizon because the ethical investment portfolios are subgroups of the market portfolio, causing limited potential diversification benefits (Bauer, Otten, and Rad, 2006). In addition, conventional stock indices may outperform Islamic investment since the ethical and ratio screenings might cause additional screening and monitoring costs, accessibility of a smaller investment universe, and limited potential for diversification.

Therefore, since diversification benefit of Islamic equity is mixed, this paper will provide another empirical evidence by examining diversification benefit of Islamic equity to Southeast Asia investors.

3. Data and methodology

We use daily data of Islamic indices in four regions namely Islamic World equity, US, Europe and Asia Pacific. Islamic World is studied to examine global diversification of Islamic equity then we narrow down to Islamic equity in US, Europe and Asia Pacific regions. Four Islamic indices are used namely Dow Jones Islamic Market World Index, Dow Jones Islamic Market US Index, Dow Jones Islamic Market Europe Index, and Dow Jones Islamic Market Asia Pacific Index

Conventional equity indices of six Southeast Asia countries are used. Highest market capitalization indices are chosen namely Thailand, Malaysia, Indonesia, Singapore, Philippines, and Vietnam. For Southeast Asian indices, we use Stock Exchange of Thailand SET Index (Thailand), FTSE Bursa Malaysia KLCI Index (Malaysia), Jakarta Stock Exchange Composite Index (Indonesia), Straits Times Index STI (Singapore), Philippines Stock Exchange PSEi Index (Philippines) and Vietnam Ho Chi Minh Stock Index (Vietnam).

All data are sourced from Bloomberg. The sample period contains daily data from 1 Jan 2009 to 1 Jan 2018. Daily return of each index is calculated as $R_t = \ln(P_t) - \ln(P_{t-1})$. Then MGARCH-DCC is applied to find diversification benefit, estimating conditional volatility and correlation between Islamic indices and Southeast Asia as the whole region. Then Wavelet coherence is applied in Southeast Asian as the whole region and in each Southeast Asian country to decompose return into many holding periods to further observe different horizon diversification benefit. The theories of Wavelets and MGARCH are as follow.

3.1. Multivariate GARCH-DCC

In a multivariate GARCH (p,q) model, conditional variance and covariance of each asset depend upon not only on its own past conditional variance and past squared innovations but also on the past squared innovations and past conditional variances of the other assets. The multivariate GARCH model is used to estimate the Dynamic Conditional Correlations (DCC) for a portfolio composed of returns on conventional and Islamic stock indices.

MGARCH-DCC gives more robust result than other volatility models. It is more robust than MGARCH-CCC because MGARCH-CCC only allows the variances of each variable to be time varying but keeps the correlation constant while MGARCH-DCC allows conditional correlations among variables to be dynamic. In addition, MGARCH-DCC is more developed than ARCH and GARCH models which do not allow multivariate modelling. The mathematical derivation of MGARCH is as follow.

Let r_t be an $m \times 1$ vector of asset returns at close day t assumed to have a conditional multivariate t distribution with means μ_{t-1} , and the non-singular variance-covariance matrix Σ_{t-1} , and $v_{t-1} > 2$ degrees of freedom. Here we are not concerned with how mean returns are predicted and take μ_{t-1} as given. For the specification of Σ_{t-1} , we follow Bollerslev (1990) and Engle (2002) in considering the decomposition

$$\Sigma_{t-1} = D_{t-1} R_{t-1} D_{t-1}, \quad (1)$$

where

$$D_{t-1} = \begin{pmatrix} \sigma_{1,t-1} & & & & \\ & \sigma_{2,t-1} & & & \\ & & 0 & & \\ & & & \ddots & \\ & & & & \sigma_{m,t-1} \end{pmatrix} \quad (2)$$

$$R_{t-1} = \begin{pmatrix} 1 & \rho_{12,t-1} & \rho_{13,t-1} & \cdots & \rho_{1m,t-1} \\ \rho_{21,t-1} & 1 & \rho_{23,t-1} & \cdots & \rho_{2m,t-1} \\ \rho_{31,t-1} & \rho_{32,t-1} & 1 & \cdots & \rho_{3m,t-1} \\ \rho_{m,t-1} & \cdots & \rho_{mm,m-1,t-1} & \cdots & \rho_{m-1,m,t-1} \end{pmatrix} \quad (3)$$

$R_{t-1} = (\rho_{ij}, t-1) = (\rho_{ji}, t-1)$ is the symmetric $m \times m$ correlation matrix, and D_{t-1} is the $m \times m$ diagonal matrix with $\sigma_{i,t-1}$; $i=1,2, \dots, m$ denoting the conditional volatility of the i th asset return. More specifically,

(4)

$$\sigma_{i,t-1}^2 = V(r_{it} | \Omega_{t-1}),$$

and $\rho_{ij,t-1}$ are conditional pair-wise return correlations defined by

$$\rho_{ij,t-1} = \frac{\text{Cov}(r_{it}, r_{jt} | \Omega_{t-1})}{\sigma_{i,t-1} \sigma_{j,t-1}}, \quad (5)$$

where Ω_{t-1} is the information set available at close of day $t-1$. Clearly, $\rho_{ij,t-1} = 1$; for $i=j$.

Bollerslev (1990) considers (1) with a constant correlation matrix $R_{t-1} = R$. Engle (2002) allows for R_{t-1} to be time-varying and proposes a class of multivariate GARCH models labeled as dynamic conditional correlation (DCC) models. An alternative approach would be to use the conditional heteroscedastic factor model, where the vectors of unobserved common factors are assumed to be conditionally heteroscedastic. Parsimony is achieved by assuming that the number of common factors is much less than the number of assets under consideration. The decomposition of Σ_{t-1} in (1) allows for a separate specification of the conditional volatilities and conditional cross-asset return correlations. For example, one can utilize the GARCH (1,1) model for $\sigma_{i,t-1}^2$, namely

$$V(r_{it} | \Omega_{t-1}) = \sigma_{i,t-1}^2 = \overline{\sigma_i^2} (1 - \lambda_{1i} - \lambda_{2i}) + \lambda_{1i} \sigma_{i,t-1}^2 + \lambda_{2i} r_{i,t-1}^2, \quad (6)$$

where σ_i^2 is the unconditional variance of the i th asset return. Under the restriction $\lambda_{1i} + \lambda_{2i} = 1$, the unconditional variance does not exist and we have the integrated GARCH (IGARCH) model, which is used extensively in the professional financial community and which is mathematically equivalent to the exponential smoother applied to the $r_{i,t-s}^2$

$$\sigma_{i,t-1}^2(\lambda_i) = (1 - \lambda_i) \sum_{s=1}^{\infty} \lambda_i^{s-1} r_{i,t-s}^2 \quad 0 < \lambda_i < 1 \quad (7)$$

For cross-asset correlations, Engle proposes the use of the following exponential smoother applied to the standardized returns

$$\hat{\rho}_{ij,t-1}(\varnothing) = \frac{\sum_{s=1}^{\infty} \varnothing^{s-1} z_{i,t-1} z_{j,t-1}}{\sqrt{\sum_{s=1}^{\infty} \varnothing^{s-1} z_{i,t-s}^2} \sqrt{\sum_{s=1}^{\infty} \varnothing^{s-1} z_{j,t-s}^2}} \quad (8)$$

where the standardized returns are defined by

$$z_{it} = \frac{r_{it}}{\sigma_{i,t-1}(\lambda_i)}. \quad (9)$$

For the estimation of the unknown parameters, $\lambda_1, \lambda_2, \lambda_3, \dots, \lambda_m$ and ϕ , Engle (2002) proposes a two-step procedure, where in the first step individual GARCH(1,1) models are fitted to the m asset returns separately, and then the coefficient of the conditional correlations, ϕ , is estimated by the Maximum Likelihood method, assuming that asset returns are conditionally Gaussian. This procedure has two main drawbacks. First, the Gaussianity assumption does not hold for daily returns and its use can underestimate the portfolio risk. Second, the two-stage approach is likely to be inefficient even under Gaussianity.

3.2. Wavelet Coherence

In this paper, we examine the stock return co-movement between Islamic equity indices and Conventional Southeast Asia equity indices through a novel approach, Wavelet Coherence. Wavelet Coherence constitutes a very promising tool as it represents a refinement in terms of analysis in the sense that both time and frequency domains are taken into account. In particular, wavelet analysis provides a unified framework to measure co-movement in the time–frequency space. Mathematic presentation of wavelets is as follow.

For the wavelet decomposition, the studies of Grinsted et al. (2004) and Aguiar-Conraria and Soares (2011) apply wavelet coherency in the form of continuous wavelet transform on the return series in order to capture co-movement in time-frequency space. The continuous wavelet transform of a time series x_t with respect to ψ is a function of two variables given by the following convolution:

$$W_x(\tau, s) = \int_{-\infty}^{+\infty} x(t) \bar{\psi}_{\tau, s}(t) dt = \frac{1}{\sqrt{s}} \int_{-\infty}^{+\infty} x(t) \bar{\psi}\left(\frac{t - \tau}{s}\right) dt, \quad (10)$$

where the bar denotes the complex conjugate, τ is the time position or translation parameter controlling its location, s is the scale or dilation parameter that controls the width of the wavelet, and $1/\sqrt{s}$ is a normalization factor to make sure that the wavelet transforms are comparable

across scales and time series. In terms of the mother wavelet, the most frequent choice is the Morlet wavelet, which is given by:

$$\psi_{\omega_0}(t) = \pi^{-(1/4)} e^{j\omega_0 t} e^{-(t^2/2)} \quad (11)$$

The Morlet wavelet is a complex sine wave within a Gaussian envelope, while ω_0 is the wave number. Commonly, the results are obtained with a particular choice of ω_0 equal to 6 as it provides a good balance between time and frequency localization (see, for example, Grinsted et al., 2004). Aguiar- Conraria and Soares (2011) mention that the Morlet wavelet is frequently used mainly due to four properties: (1) the three sensible ways of converting wavelet scales into frequencies are equal; (2) it has optimal joint time-frequency concentration; (3) the time radius and the frequency radius are equal; (4) it is an analytic wavelet.

Similar to Fourier analysis, several interesting features can be obtained in the wavelet domain. We can define the wavelet power spectrum as:

$$(WPS)_x(\tau, s) = |W_x(\tau, s)|^2 \quad (12)$$

This measures the relative contribution at each time and each scale to the time series' variance. Similarly, we can define the cross-wavelet spectrum as:

$$W_{xy}(\tau, s) = W_x(\tau, s) \overline{W_y(\tau, s)}, \quad (13)$$

where $W_{xy}(\tau, s)$ and $\overline{W_{xy}(\tau, s)}$ are wavelet transforms of two time series $x(t)$ and $y(t)$.

The cross-wavelet spectrum can be decomposed into real and imaginary parts, since the mother wavelet is in general complex. We define the cross wavelet power as $|W_{xy}(\tau, s)|$, which depicts the local covariance between two time-series at each time and frequency. On the other hand, the wavelet coherency has the major advantage of being normalized by the power spectrum of the two time series. As in Fourier analysis, we can define the wavelet coherency of the two given time series $x(t)$ and $y(t)$ as:

$$R_{xy}(\tau, s) = \frac{|S(W_{xy}(\tau, s))|}{\sqrt{S(|W_{xx}(\tau, s)|) S(|W_{yy}(\tau, s)|)}} \quad (14)$$

where S denotes a smoothing operator in both time and scale.

We can use wavelet squared coherency to measure the co-movement of two time series over time and across frequencies. Such a wavelet-based measure allows for a richer description of the co-movement between two variables of interest. Similar to the squared coefficient of correlation, $R^2(\tau, s)$ is in a range between 0 and 1 with a high (low) value indicating a strong (weak) co-movement. Hence, by observing the contour plot of the above measure, we can identify the regions in time–frequency space where the two time series move together and, specifically, assess both time and frequency varying features of the co-movement. We will rely on Monte Carlo simulations for statistical inference.

The use of a complex-valued wavelet is a major advantage, as we can compute the phase of the wavelet transform of each series. By computing the phase difference, we can obtain information about the possible delays of the oscillations of the two series as a function of time and scale/frequency. The phase difference can be defined as:

$$\phi_{x,y}(s, \tau) = \tan^{-1} \left(\frac{\Im(W_{xy}(s, \tau))}{\Re(W_{xy}(s, \tau))} \right) \quad (15)$$

The information of the signs of each part is to determine the value of $\phi_{x,y} \in (-\pi, \pi)$. A phase difference of zero indicates that the time series co-move at the specified frequency; if $\phi_{x,y} \in (0, \pi/2)$, then the series move in a phase with time series y leading x ; $\phi_{x,y} \in (-\pi/2, 0)$ indicates a leading role of x ; a phase difference that is π (or $-\pi$) will be an anti-phase relation; if $\phi_{x,y} \in (\pi/2, \pi)$, then x is leading; time series y is leading if $\phi_{x,y} \in (-\pi, -\pi/2)$.

The use of wavelets assists in addressing the issues raised by Bodart and Candelon (2009), since we can observe the causal structure better than with static correlation. This allows us to take into account the underlying dynamic structure and deal with the problem of asymmetry. In addition, the frequency domain allows us to observe diversification benefit at varying frequencies.

4. Empirical results

Multivariate GARCH is applied to investigate conditional volatilities and correlations between returns of Conventional Southeast Asian equity and Islamic equity in World, US, EU and Asia Pacific region. Conditional volatility shows the trend movement among return of Islamic indices and conventional equity index. Conditional correlation reveals the co-movement of return between each conventional Southeast Asia country's equity index and each Islamic index. We will examine diversification benefit in conventional Southeast Asia equity (the whole region) and six Southeast Asian countries' equity. From [Table 1](#), the following notations are used.

Table 1: Selected indices: Conventional equity indices in blue, Islamic equity indices in green

Symbol	Meaning	Index
CSEA	Return of Conventional Southeast Asia equity	Return of Southeast Asia composite index
CTH	Return of Conventional Thailand equity	Return of Stock Exchange of Thailand SET Index
CMY	Return of Conventional Malaysia equity	Return of FTSE Bursa Malaysia KLCI Index
CIND	Return of Conventional Indonesia equity	Return of Jakarta Stock Exchange Composite Index
CPHP	Return of Conventional Philippines equity	Return of Philippines Stock Exchange PSEi Index
CVN	Return of Conventional Vietnam equity	Return of Vietnam Ho Chi Minh Stock Index
CSGR	Return of Conventional Singapore equity	Return of Straits Times Index STI
ISWORLD	Return of Islamic World equity	Return of Dow Jones Islamic Market World Index
ISUS	Return of Islamic US equity	Return of Dow Jones Islamic Market US Index
ISEU	Return of Islamic EU equity	Return of Dow Jones Islamic Market Europe Index
ISAP	Return of Islamic Asia Pacific equity	Return of Dow Jones Islamic Market Asia Pacific Index

First, Gaussian DCC Model and the t-DCC model is compared by plotting the estimated conditional volatilities and correlations. The comparison between the Gaussian DCC Model and the t-DCC model serves as a preliminary step to determine which model is relatively more significant. [Table 2](#) presents the maximum likelihood estimates of the Gaussian DCC model for the returns of the conventional and Islamic equity index returns. The volatility parameters observed in this model are highly significant with estimates of $\lambda 1_i, i = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11$ are very close to unity, implying a gradual volatility decay. The estimated unconditional volatilities and correlations are reported in [Table 3](#). Then, in [Table 4](#), the ML estimates of the t-DCC model were calculated to determine which model is more appropriate.

Table 2: Maximum likelihood estimates of the Gaussian DCC model on stock indices daily returns.

Parameter	Estimate	Standard Error	T-Ratio[Prob]
lambda1_ISWORLD	0.9360	0.0040	234.6793[.000]
lambda1_ISUS	0.9310	0.0049	189.5867[.000]
lambda1_ISEU	0.9242	0.0064	143.8029[.000]
lambda1_ISAP	0.9352	0.0052	178.4360[.000]
lambda1_CSEA	0.9394	0.0041	230.7913[.000]
lambda1_CTH	0.9126	0.0096	95.3512[.000]
lambda1_CMY	0.9080	0.0156	58.2850[.000]
lambda1_CIND	0.9310	0.0066	140.7196[.000]
lambda1_CSGPR	0.9241	0.0081	114.0164[.000]
lambda1_CPHP	0.8292	0.0238	34.7726[.000]
lambda1_CVN	0.8377	0.0193	43.4902[.000]
lambda2_ISWORLD	0.0586	0.0033	17.5368[.000]
lambda2_ISUS	0.0622	0.0040	15.3658[.000]
lambda2_ISEU	0.0688	0.0054	12.7416[.000]
lambda2_ISAP	0.0583	0.0044	13.2592[.000]
lambda2_CSEA	0.0549	0.0034	15.9918[.000]
lambda2_CTH	0.0769	0.0079	9.7911[.000]
lambda2_CMY	0.0692	0.0104	6.6789[.000]
lambda2_CIND	0.0588	0.0052	11.2467[.000]
lambda2_CSGPR	0.0690	0.0070	9.8698[.000]
lambda2_CPHP	0.1089	0.0130	8.3605[.000]
lambda2_CVN	0.1333	0.0145	9.2026[.000]
delta	0.9812	0.0005	1896.2[.000]
Maximized Log-Likelihood = 105786.0			

Table 3: Unconditional correlation and volatilities of the Gaussian DCC model.

	ISWORLD	ISUS	ISEU	ISAP	CSEA	CTH	CMY	CIND	CSGPR	CPHP	CVN
ISWORLD	0.009	0.922	0.833	0.626	0.526	0.373	0.313	0.334	0.479	0.172	0.134
ISUS	0.922	0.010	0.616	0.374	0.294	0.221	0.164	0.172	0.289	0.057	0.073
ISEU	0.833	0.616	0.012	0.566	0.508	0.361	0.278	0.307	0.443	0.133	0.113
ISAP	0.626	0.374	0.566	0.010	0.836	0.550	0.565	0.609	0.728	0.439	0.218
CSEA	0.526	0.294	0.508	0.836	0.008	0.705	0.681	0.787	0.801	0.540	0.213
CTH	0.373	0.221	0.361	0.550	0.705	0.010	0.406	0.475	0.506	0.326	0.133
CMY	0.313	0.164	0.278	0.565	0.681	0.406	0.006	0.487	0.511	0.430	0.190
CIND	0.334	0.172	0.307	0.609	0.787	0.475	0.487	0.011	0.543	0.413	0.139
CSGPR	0.479	0.289	0.443	0.728	0.801	0.506	0.511	0.543	0.009	0.346	0.168
CPHP	0.172	0.057	0.133	0.439	0.540	0.326	0.430	0.413	0.346	0.011	0.187
CVN	0.134	0.073	0.113	0.218	0.213	0.133	0.190	0.139	0.168	0.187	0.013

From Table 4, the ML estimates of the t-DCC model on the stock indices daily returns show that all return volatility estimates are statistically significant and near to unity, implying a gradual decay in volatility under the t-DCC model. The maximized log-likelihood value of 106559.9 is larger than the one obtained under the Gaussian model which was 105786 from Table 2. In addition, the estimated degrees of freedom for the t-normal distribution is below 30. Thus, this suggests that the t-distribution is a more appropriate model for capturing the fat-tailed nature of the distribution of the stock returns.

As t-DCC model is more robust than Gaussian DCC model, our analysis will be based on t-DCC model. From Table 4, the volatility parameters of all indices are highly significant, indicating gradual volatility decay. This means volatility of indices gradually cancels out after following a shock in the market. The summation of lambda 1 and lambda 2 of each index is

less than unity, indicating that its volatility does not follow the Integrated Generalized Auto Regressive Conditional Heteroskedasticity (IGARCH). In other words, a shock to volatilities is not permanent. This means that investors and portfolio managers would have a high chance of losing their investment despite making high profit in the short run.

Table 4: Maximum likelihood estimates of t-DCC model on stock indices daily returns

Parameter	Estimate	Standard Error	T-Ratio[Prob]
lambda1_ISWORLD	0.94063	0.0041615	226.0319[.000]
lambda1_ISUS	0.93671	0.0049897	187.7290[.000]
lambda1_ISEU	0.93454	0.0064377	145.1671[.000]
lambda1_ISAP	0.9416	0.0051357	183.3438[.000]
lambda1_CSEA	0.94548	0.0043247	218.6235[.000]
lambda1_CTH	0.92463	0.0086241	107.2143[.000]
lambda1_CMY	0.91755	0.015404	59.5653[.000]
lambda1_CIND	0.93824	0.0066293	141.5285[.000]
lambda1_CSGPR	0.93078	0.0084352	110.3444[.000]
lambda1_CPHP	0.83328	0.029188	28.5489[.000]
lambda1_CVN	0.83134	0.02231	37.2628[.000]
lambda2_ISWORLD	0.053941	0.0034508	15.6313[.000]
lambda2_ISUS	0.056483	0.0040393	13.9832[.000]
lambda2_ISEU	0.058649	0.0053589	10.9442[.000]
lambda2_ISAP	0.050627	0.0041571	12.1785[.000]
lambda2_CSEA	0.048423	0.0035768	13.5382[.000]
lambda2_CTH	0.065881	0.0070086	9.3999[.000]
lambda2_CMY	0.060616	0.010026	6.0459[.000]
lambda2_CIND	0.051794	0.0051658	10.0264[.000]
lambda2_CSGPR	0.060834	0.0070226	8.6626[.000]
lambda2_CPHP	0.099397	0.01521	6.5348[.000]
lambda2_CVN	0.13017	0.015814	8.2314[.000]
delta	0.98198	5.47E-04	1796.5[.000]
df	8.1049	0.34659	23.3846[.000]
Maximized Log-Likelihood = 106559.9			

From Table 5, the on-diagonals explain the unconditional volatilities of the indices. If an index has unconditional volatility close to zero, that index has lower volatility. In contrast, if an index has the unconditional volatility close to 1, it has higher volatility levels. For easier comparison, we ranked all indices conditional volatilities in Table 6. From Table 6, unconditional volatilities ranges from 0.0058 to 0.0127, showing that Malaysia equity index has the least volatility while Singapore index has the highest volatility.

Among Islamic equity, ranging from lowest to highest volatility, we have Islamic World, Islamic US, Islamic Asia Pacific, and Islamic Europe. Low volatility of asset enhances investors' portfolio performance as it could reduce total portfolio risk. However, we need to examine correlation further to identify diversification benefit.

Table 5: Unconditional correlation and volatilities of t-DCC model.

	ISWORLD	ISUS	ISEU	ISAP	CSEA	CTH	CMY	CIND	CSGPR	CPHP	CVN
ISWORLD	0.009	0.922	0.833	0.626	0.526	0.373	0.313	0.334	0.479	0.172	0.134
ISUS	0.922	0.010	0.616	0.374	0.294	0.221	0.164	0.172	0.289	0.057	0.073
ISEU	0.833	0.616	0.012	0.566	0.508	0.361	0.278	0.307	0.443	0.133	0.113
ISAP	0.626	0.374	0.566	0.010	0.836	0.550	0.565	0.609	0.728	0.439	0.218
CSEA	0.526	0.294	0.508	0.836	0.008	0.705	0.681	0.787	0.801	0.540	0.213
CTH	0.373	0.221	0.361	0.550	0.705	0.010	0.406	0.475	0.506	0.326	0.133
CMY	0.313	0.164	0.278	0.565	0.681	0.406	0.006	0.487	0.511	0.430	0.190
CIND	0.334	0.172	0.307	0.609	0.787	0.475	0.487	0.011	0.543	0.413	0.139
CSGPR	0.479	0.289	0.443	0.728	0.801	0.506	0.511	0.543	0.009	0.346	0.168
CPHP	0.172	0.057	0.133	0.439	0.540	0.326	0.430	0.413	0.346	0.011	0.187
CVN	0.134	0.073	0.113	0.218	0.213	0.133	0.190	0.139	0.168	0.187	0.013

Table 6: Ranks of the unconditional volatilities of Islamic and conventional equity indices returns

No.	Indices	Unconditional volatility
1	FTSE Bursa Malaysia KLCI Index	0.0058
2	Southeast Asia composite index	0.0084
3	Dow Jones Islamic Market World Index	0.0087
4	Philippines Stock Exchange PSEi Index	0.0088
5	Dow Jones Islamic Market US Index	0.0099
6	Dow Jones Islamic Market Asia Pacific Index	0.0101
7	Stock Exchange of Thailand SET Index	0.0101
8	Vietnam Ho Chi Minh Stock Index	0.0105
9	Jakarta Stock Exchange Composite Index	0.0109
10	Dow Jones Islamic Market Europe Index	0.0119
11	Straits Times Index STI	0.0127

The off-diagonal elements in [Table 5](#) show the unconditional correlations. We can see that the correlation between Islamic Asia Pacific index (ISAP) and all conventional Southeast Asia indices (CSEA, CTH, CMY, CIND, CSGPR, CPHP, CVN) are higher than the correlation with other Islamic indices (ISWORLD, ISUS, ISEU). This is because Southeast Asian market is highly integrated into Asia Pacific market as Southeast Asia is one of the main drivers of the whole Asia Pacific economy. Among Southeast Asian countries, the correlation of conventional Singapore index and Islamic Asia Pacific is highest at 0.72. Singaporean market is highly cointegrated with the Asia Pacific market as many Asia Pacific companies are listed in Singapore stock exchange.

In contrast, the correlation between Islamic US index (ISUS) and all conventional Southeast Asia indices (CSEA, CTH, CMY, CIND, CSGPR, CPHP, CVN) are the lowest among other Islamic indices (ISWORLD, ISAP, ISEU). This is because nature of US economy is different from Southeast Asia economy. The US economy significantly based on industrial sector. It also has one of the largest service and financial sector. On the contrary, Southeast Asian economy is heavily driven by agricultural sector.

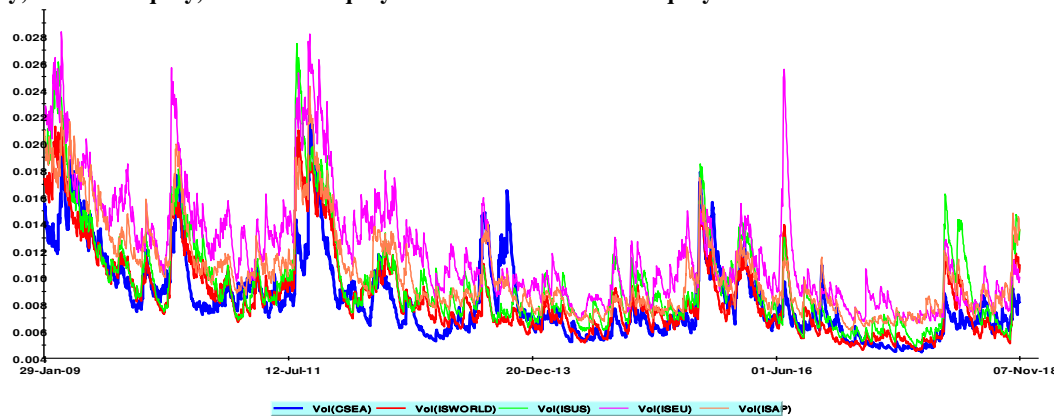
Next, we will examine the dynamic conditional correlations which capture the time-varying properties in the volatilities and the correlations. We will analyze the linkage

between all Islamic equity (World, US, EU, Asia Pacific) and conventional equity of the whole Southeast Asia equity.

Conventional Southeast Asia equity (the whole region) and Islamic equity

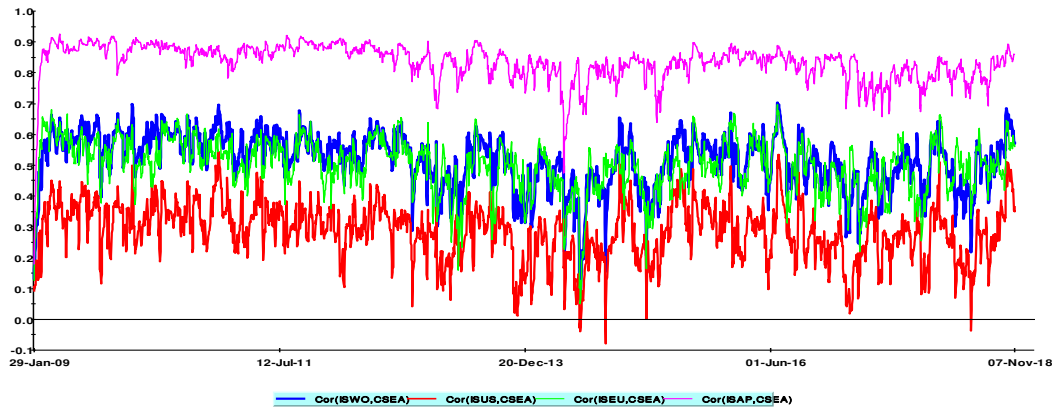
From Figure 1, overall, all indices move together, illustrating market cointegration. They have high volatilities during 2009 to 2012 due to aftermath of global financial crisis in 2008 and European sovereign debt crisis. Volatilities gradually decline from 2012 to 2018. Islamic Europe equity has relatively higher volatilities than other indices while conventional Southeast Asia has relatively lower volatilities.

Figure 1: Multivariate GARCH dynamic conditional volatilities – Conventional Southeast Asia equity, Islamic World equity, Islam US equity, Islamic EU equity and Islamic Asia Pacific equity.



From Figure 2, diversification benefits of Islamic equity to conventional Southeast Asia differ among Islamic World, US, EU and Asia Pacific. For Southeast Asian investors, the benefit is greatest with Islamic US equity as correlations for the entire period are the lowest, varying from 0.2 to 0.4. Diversification benefit is due to different business between US and Southeast Asia equity. The US has a highly diversified, world-leading service and industrial sector which manufactures technological products. On the other hand, Southeast Asia economy depends more on agriculture products.

Figure 2: Multivariate GARCH dynamic conditional correlations (DCC) – Conventional Southeast Asia equity with Islamic World equity, Islam US equity, Islamic EU equity and Islamic Asia Pacific equity.



The diversification benefit of Islamic World to Southeast Asia varies from 0.4 to 0.6. This shows that Islamic equity globally have benefit for conventional Southeast Asia investors. Since Islamic World equity index includes companies from Islamic Asia Pacific index which has high correlation to Southeast Asian equity, diversification benefit of Islamic World is less, comparing to Islamic equity in specific region such as US. The diversification benefit of Europe is moderate, fluctuating from 0.4 to 0.6. The diversification benefit stems from unique nature of EU economy which highly rely on the services sector and less rely on agricultural sector. Correlation of Islamic Europe and Islamic World is quite similar.

In contrast, there is limited diversification benefit with Islamic Asia Pacific as correlation is very high at around 0.9. The nature of Southeast Asia economy shares many similarities with that of Asia Pacific region which is mainly agricultural-based economy. In addition, Southeast Asian market is highly integrated into Asia Pacific market as Southeast Asia is one of the main drivers of the whole Asia Pacific economy.

Wavelet Coherence

MGARCH does not demonstrate diversification benefit of different investment horizons. However, investors have different investment periods ranging from few days short-term speculators to many years long-term investors. Therefore, we will analyze diversification benefit of different investment holding periods over time by applying Wavelet Coherence. We will investigate correlations between Islamic equity indices and each Southeast Asian equity index.

We define less-than 16 days holding period as **very-short-term** investment, 16-64 days holding period as **short-term** investment, 64-256 days holding period as **medium-term** investment and over 256 days holding period as **long-term** investment. Insights about diversification potentials in different time scales are useful to investors. The continuous wavelet transform of each conventional Southeast Asian country index and all Islamic stock indices are presented in Figure 13 to 19 from 2 days holding period (very-short-term) to over 256 days holding period (long-term). The lower-horizontal axis represents the time in terms of number of trading days whereas the vertical axis refers to the investment horizon. In addition, the upper-horizontal axis represent time in terms of actual years. The values for the 5% significance level represented by the curved line were obtained from the Monte Carlo simulations.

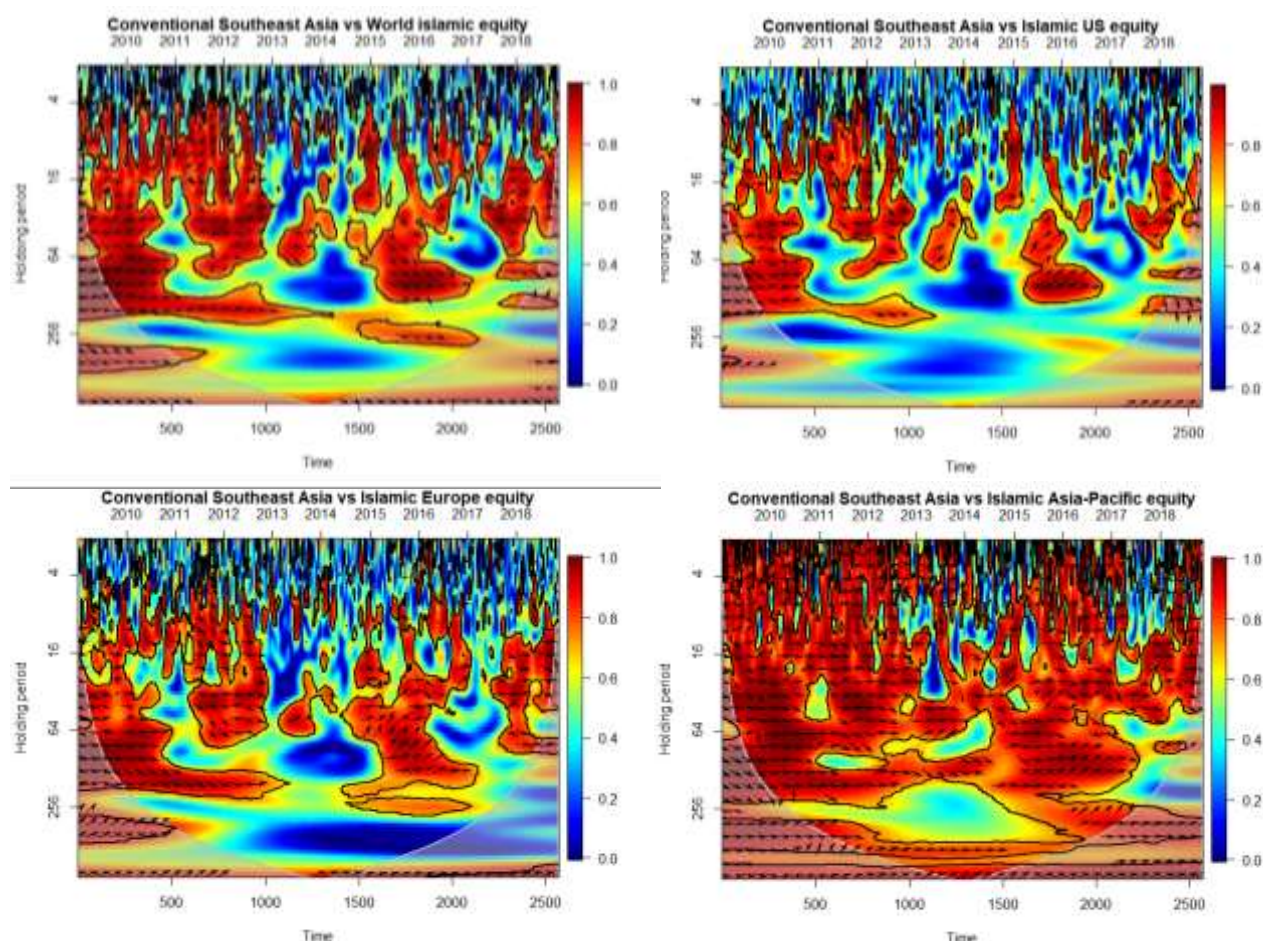
The colour code for power or strength of correlation ranges from blue (low coherency, near zero) to red (high coherency, near one). The vectors pointing to the right mean that the indexes are in phase but if they point to the left it means that the indices are out of phase. To the right and up means that the first series is lagging. To the right and down means that the first series is leading. To the left and up indicates that the first series lagging, whereas first series becomes leading when the arrows are pointing towards the left and down.

Holding periods diversification benefit:

Conventional Southeast Asia equity (the whole region) and all Islamic equities

From [Figure 3](#), diversification benefit exists for Southeast Asia investors who have holding period less-than 16 days (very-short-term investment) in Islamic World, US, and EU equities from 2013-2018. However, diversification benefit is limited in Islam Asia Pacific equity both in short and long investment horizons because Southeast Asia equity market is highly cointegrated with Asia Pacific market. For 16-256 days investment period (short-term and medium-term), diversification benefit is more observable in US market. For over 256 days (long-term), diversification is more observable in Europe and US market.

Figure 3: Wavelet coherence of conventional Southeast Asia with Islamic World equity, Islamic US equity, Islamic Europe equity and Islamic Asia-Pacific equity.



The low correlation between conventional and Islamic equity in some regions shows benefit of Islamic equity for conventional investors. In addition, this shows substantial level of market cointegration between Global Islamic equity regions and Southeast Asia region especially Islamic Asia Pacific. Islamic Asia Pacific index has high correlation because since Southeast Asian countries has formed ASEAN group, its bargaining power in trade has increased significantly, contributing to higher trade with other Asia Pacific countries and the rest of the world.

Islamic US equity market is interdependent with Southeast Asian market. The ASEAN countries, together, would rank 4th as an export market for the United States in 2013. US exports Electrical Machinery, Machinery, Aircraft, Mineral Fuel and Oil, and Optic and Medical Instruments. U.S. imports various agricultural products from ASEAN countries. Leading categories include rubber and allied products, tropical oils, processed fruit and vegetables, coffee, and tree nuts. Since two economies are integrated significantly,

aftermath of US financial crisis, which heavily affect Islamic US equity, causes higher correlation with Southeast Asian equity returns.

To obtain diversification benefit, investors who have exposure to Southeast Asia equity should avoid Islamic Asia Pacific equity for all holding periods. They should invest in Islamic US stocks for short-term investment (16-64 days) and in Islamic Europe and US stocks for longer term investment. However, diversification is very limited for all Islamic indices and mostly present in some short durations.

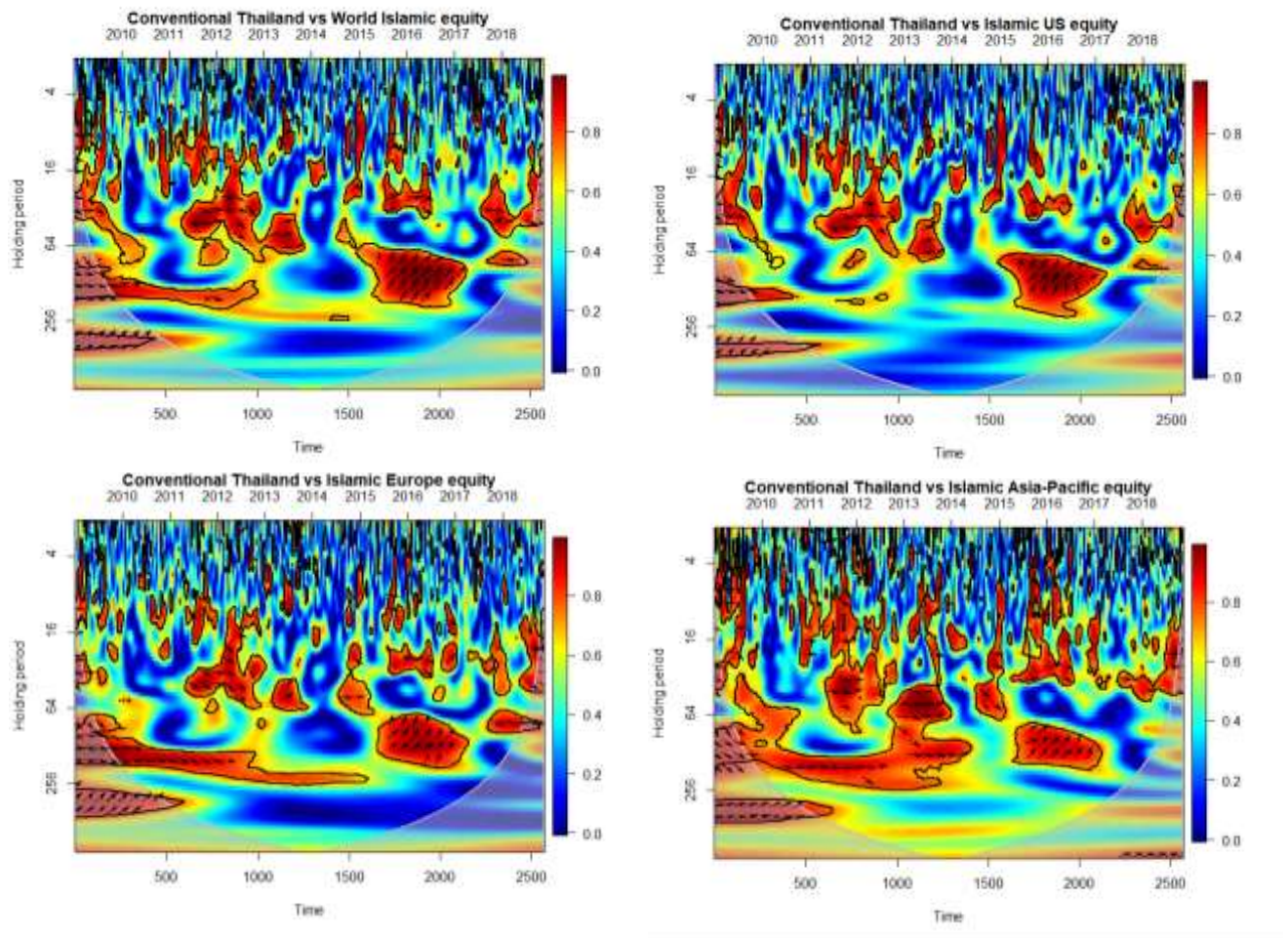
Southeast Asian market is highly correlated with Islamic Europe market due to higher integration of two markets. Southeast Asian countries represents the EU's 3rd largest trading partner outside Europe since 2012. The EU is by far the largest investor in Southeast Asian countries. In 2016 there is a huge amount of the Foreign Direct Investment (FDI) stocks into Southeast Asian countries, accounted for € 263 billion. ASEAN investment in Europe has also been growing steadily and impressively since 2014. In addition, in 2005, Southeast Asian countries signed ASEAN-EU Free Trade Agreement (AEUFTA), to enhance trade between them.

Similarly, investors who have exposure to Islamic stocks should be very careful to invest in conventional Southeast Asian equity (the whole region) as diversification benefit is small. However, diversification benefit might be larger if each country index return is considered due to each country specific characteristics. Therefore, next section we will examine diversification benefit of each Southeast Asian country index.

Conventional Thailand equity and all Islamic equities

From [Figure 4](#), for less-than 16 days investment periods (very-short-term), Conventional Thailand investors have diversification benefit in all Islamic markets even Asia Pacific. For 16-256 days holding periods (short-term and medium term), diversification benefit is greatest in Islamic US equity from 2014 to 2018. It is still observable in World and Europe region but less noticeable in Asia Pacific. For over, 256 days (long-term), high diversification potentials are evident in all Islamic indices but Asia Pacific.

Figure 4: Wavelet coherence of conventional Thailand with Islamic World equity, Islamic US equity, Islamic Europe equity and Islamic Asia-Pacific equity.



Thailand equity index correlates correlation with Islamic US index in certain periods because US is Thailand's third largest trading partner after Japan and China. In addition, US and the European Union are among Thailand's largest foreign investors. American investment in Thailand is concentrated in the petroleum and chemicals, finance, consumer products, and automobile production sectors.

Thailand economy connects to EU economy through trade channel. Thailand is the EU's third-largest trading partner in the Association of Southeast Asian Nations (ASEAN). Key exports from Thailand are machinery and electronics and transport equipment, miscellaneous manufactured articles, as well as food products. Moreover, Thailand is one of the most important destinations of European investments within ASEAN. EU is the second-largest investor in Thailand after Japan.

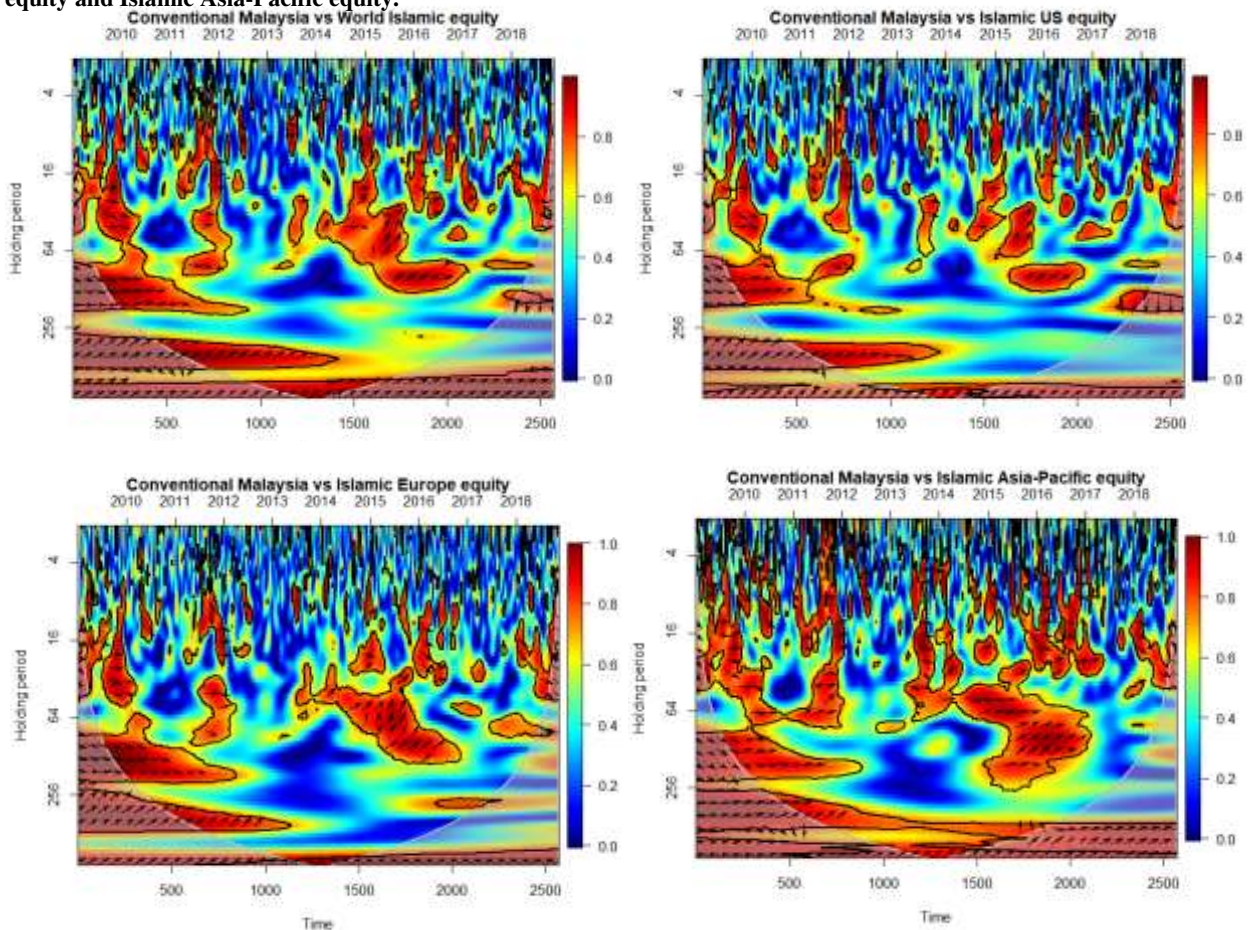
Overall, the result shows that Thailand equity market cointegrates with its own Asia Pacific region. For Thailand investors, Islamic equity provides benefit to their investment. For

short-term investors (less than 16 days), they could invest in any Islamic equity markets due to low correlations. For longer term investment, they should avoid Asia Pacific region. They are recommended to invest in Islamic Europe equity for long-term investment.

Conventional Malaysia equity and all Islamic equities

From Figure 5, for less-than 16 days investment periods (very-short-term), Conventional Malaysia investors have diversification benefit in all Islamic markets. For 16-64 days holding period (short-term), diversification benefit is present in Islamic World, US and EU from 2012-2014 and 2016-2018. For 64-256 period (medium-term), diversification is more clearly observable in Islamic World, US and EU from 2012-2018 and in Southeast Asia from 2012-2014 and 2017-2018. For over 256 days holding period (long-term), the diversification benefit is highest in Islamic Europe and US market.

Figure 5: Wavelet coherence of conventional Malaysia with Islamic World equity, Islamic US equity, Islamic Europe equity and Islamic Asia-Pacific equity.



Malaysia equity correlates with Islamic US equity to some degree with significant diversification opportunity for investors. Between two countries, Malaysian investment in the US is small but growing, particularly in leisure, gaming and biotechnology. Significant

Malaysian companies operating in the US include Genting's Resort World Casino and MOL Global, a New York Stock Exchange listed company.

EU economy connects with Malaysia economy in several ways, causing substantial correlation in certain periods. The EU is a key trade and investment partner for Malaysia, ranked Malaysia's 4th largest trading partner. The EU remains Malaysia's largest source of foreign direct investment with a total investment inflow, mainly in manufacturing. European debt crisis and its aftermath contribute to higher correlation between Malaysia and Islamic EU equity index from 2009 to 2012.

Conventional Malaysia equity cointegrates substantially with Islamic Southeast Asia equity. To obtain diversification benefit, very-short-term Malaysian investors (4-16 days) could invest in all Islamic markets. Medium-term investors should focus on Islamic US for 16-64 holding periods and EU for 64-256. Long-term investors should invest in US or EU.

Conventional Indonesia equity and all Islamic equities

From Figure 6, for less-than 16 days investment period (very-short-term), Conventional Indonesian investors have diversification benefit in all Islamic markets. For 16-64 days holding period (short-term), diversification benefit is more evident in all Islamic indices from 2012-2018. For 64-256 period (medium-term), diversification clusters in Islamic World, US and EU from 2012-2018. For over 256 days holding period (long-term), the diversification benefit is the most evident in Islamic Europe market.

Figure 6: Wavelet coherence of conventional Indonesia with Islamic World equity, Islamic US equity, Islamic Europe equity and Islamic Asia-Pacific equity.

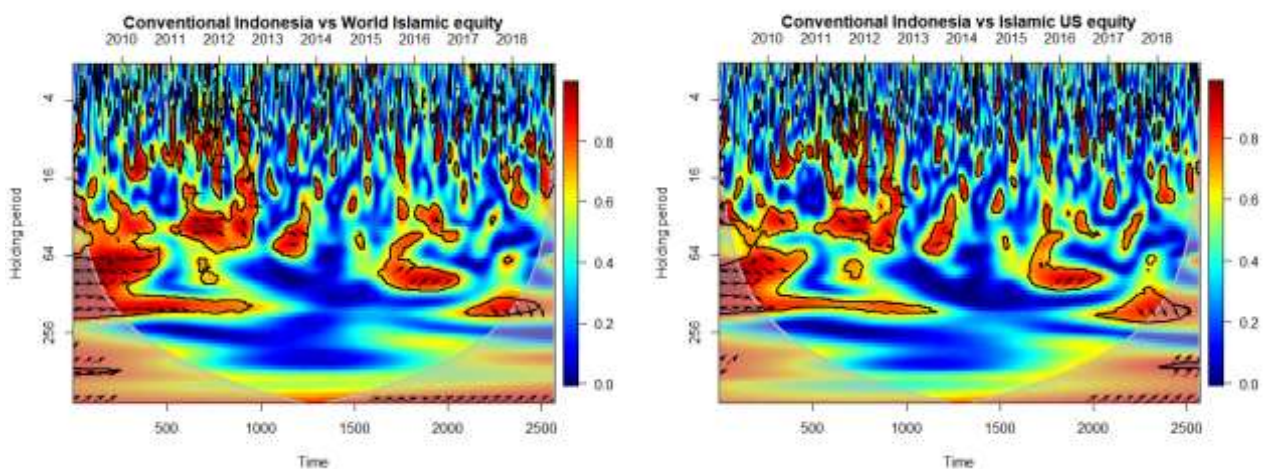
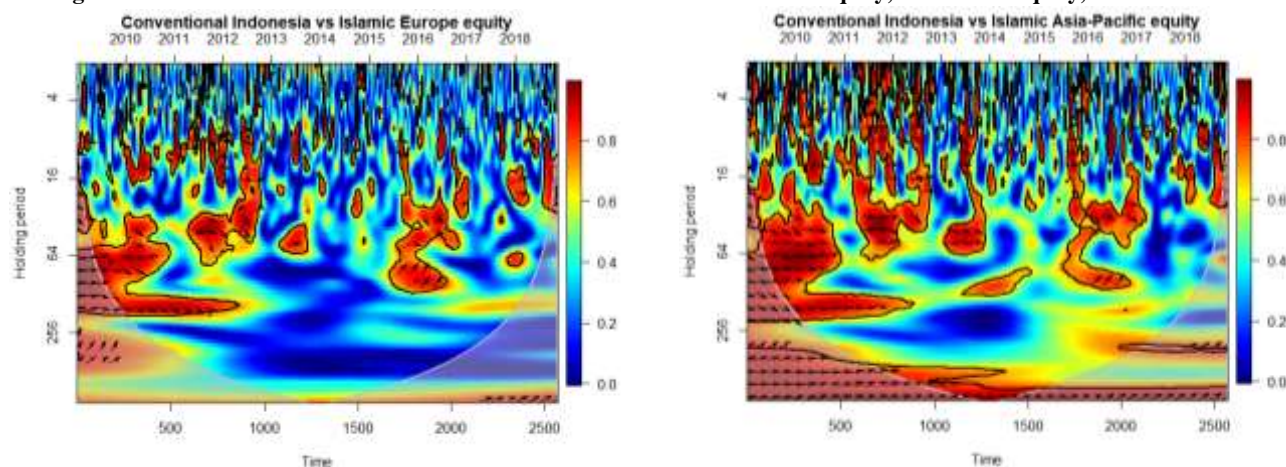


Figure 6: Wavelet coherence of conventional Indonesia with Islamic World equity, Islamic US equity, Islamic



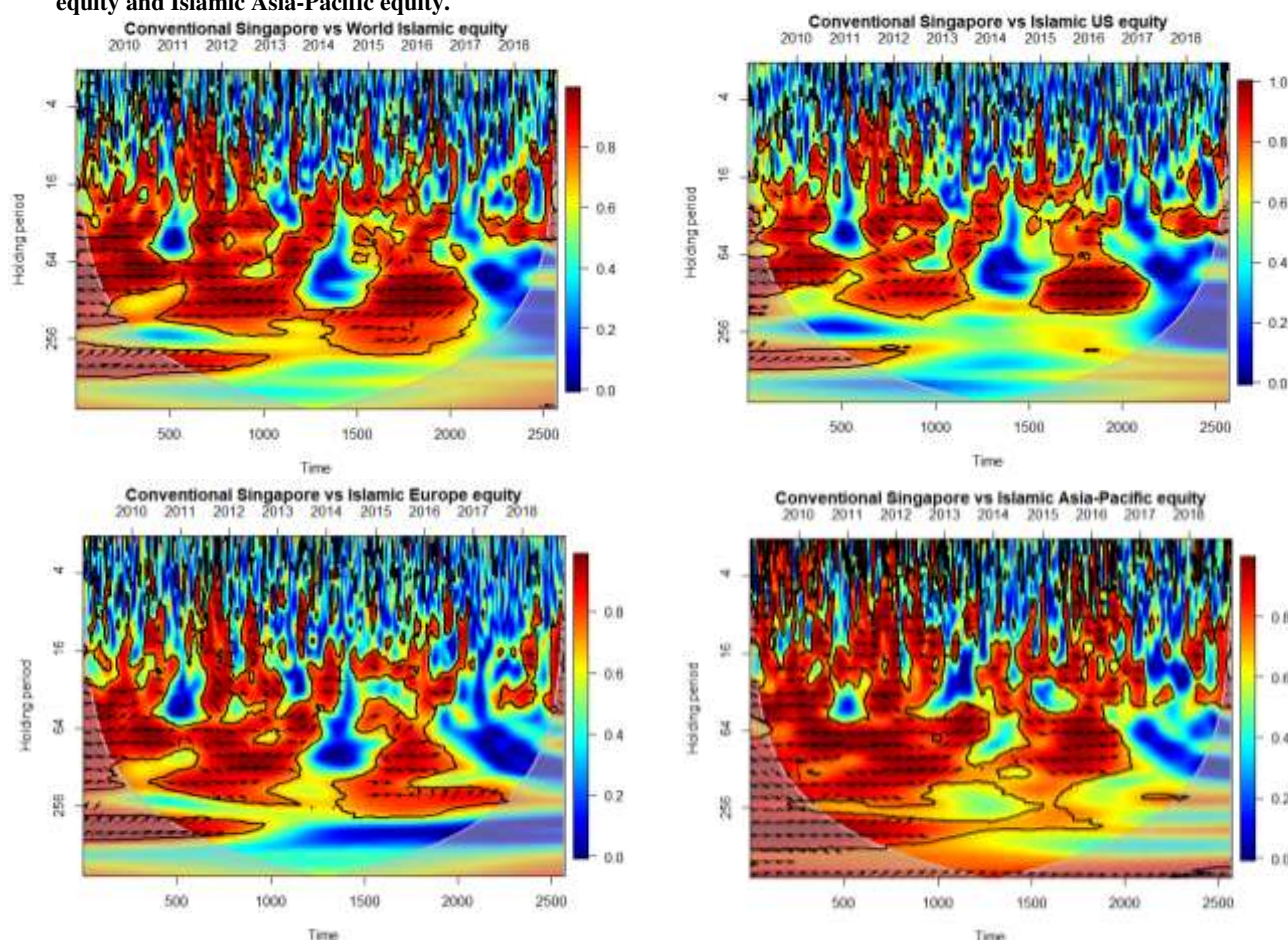
US and Indonesia stock return are correlated to some extent through trade between two countries. Indonesia's most shipped commodity to the US is agricultural and food products. These products are the backbone of the Indonesian economy. On the other hand, Indonesia imported capital intensive manufacturing goods from the US.

Cointegration between conventional Indonesia equity and Islamic Asia Pacific equity is evident as there are high correlation in many periods. To obtain diversification benefit, Indonesian investors are suggested to invest in all Islamic markets for less-than 16 days holding period (very-short-term). Short-term and medium-term investors should focus in Islamic World, US and EU for 16-256 holding period, and long-term investors in Islamic EU market.

Conventional Singapore equity and all Islamic equities

From [Figure 7](#), for less-than 16 days investment period (very-short-term), Conventional Singaporean investors have diversification benefit in Islamic World, US and EU equity while the benefit is limited in Asia Pacific. For 16-64 days holding period (short-term), diversification is very limited in all Islamic regions. For 64-256 period (medium-term), diversification benefit is present in all regions from 2017. For over 256 days holding period (long-term), the diversification benefit is the most evident in Islamic Europe market.

Figure 7: Wavelet coherence of conventional Singapore with Islamic World equity, Islamic US equity, Islamic Europe equity and Islamic Asia-Pacific equity.



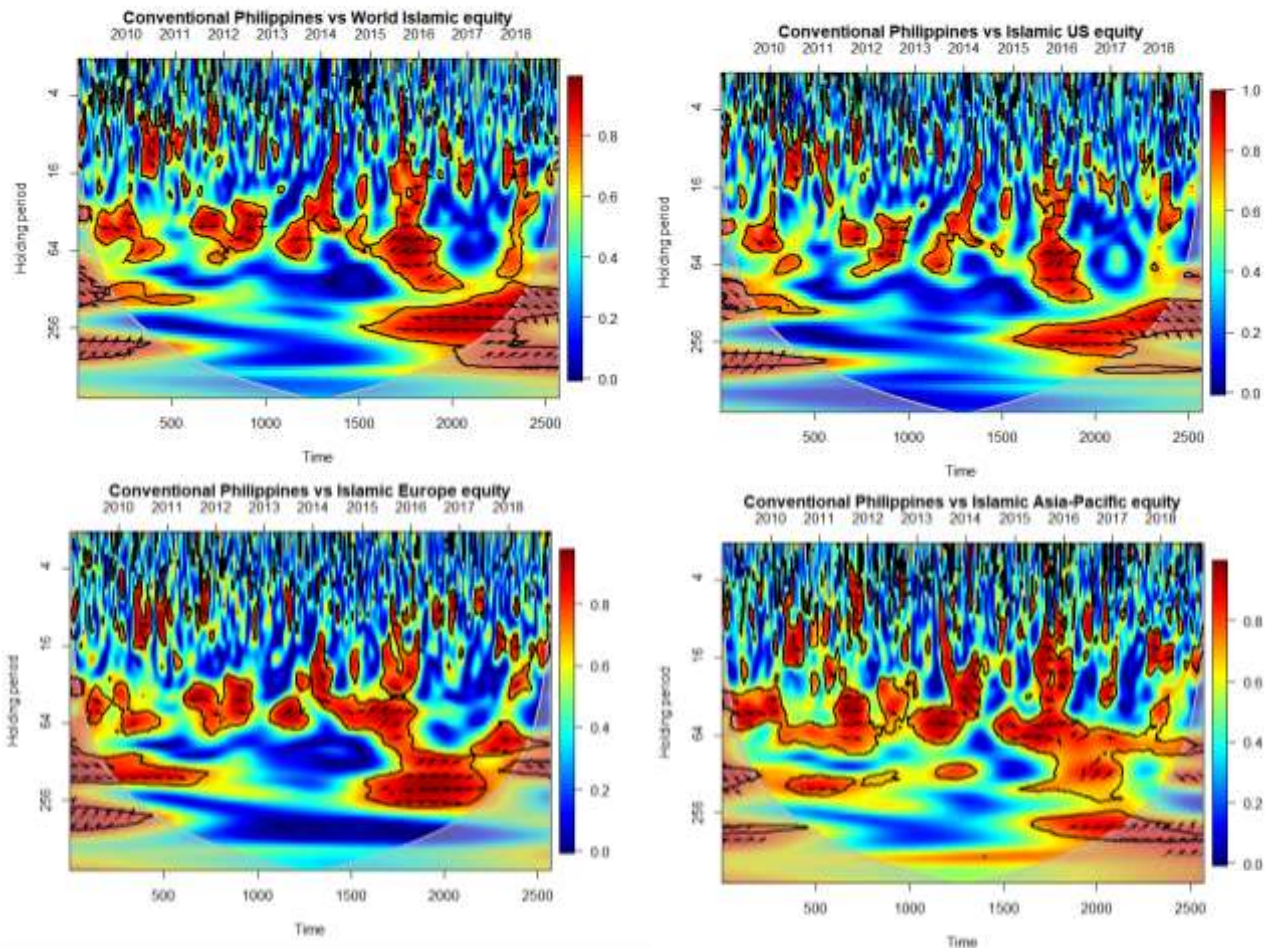
Intuitively, Singapore index has high correlation with all Islamic equity indices because Singapore economy is highly related to the world economy. The Singaporean economy is known as one of the freest, most innovative, most competitive, most dynamic and most business-friendly. The 2015 Index of Economic Freedom ranks Singapore as the second freest economy in the world and the Ease of Doing Business Index has also ranked Singapore as the easiest place to do business for the past decade. This business-friendly environment causes higher correlation with global equity market. In addition, Singapore signs Free Trade Agreement with US to lower tariffs between two countries. The reduction of trade barriers between the two countries will lead to a growth in exports.

Conventional Singapore equity market is highly correlated with Islamic Asia Pacific equity market. As expected, Singapore stock market have substantial exposure to many large Asia Pacific companies listed in Singapore market. In addition, as Singapore stock market is very developed and highly diversified, its cointegration with the world is significant. Singaporean investors have limited diversification benefit in all Islamic Equity markets. However, there are some long-run diversification potentials in EU market.

Conventional Philippines equity and all Islamic equities

From Figure 8, for less-than 16 days investment period (very-short-term), Conventional Philippines investors have diversification benefit in all Islamic markets. For 16-64 days holding period (short-term), diversification benefit can be seen in certain periods and is more observable in Islamic World, US and EU. For 64-256 period (medium-term), diversification benefit is observed from 2012-2015 but becomes scarce after 2016. For over 256 days holding period (long-term), the diversification benefit is the more evident in Islamic Europe and US market.

Figure 8: Wavelet coherence of conventional Philippines with Islamic World equity, Islamic US equity, Islamic Europe equity and Islamic Asia-Pacific equity.



One finding is that Philippines has growing correlation with all Islamic indices from 2012 onward. This is because the relatively closed Philippine economy has been opened significantly by foreign exchange deregulation, foreign investment and banking liberalization, tariff and market barrier reduction, and foreign entry into the retail trade sector. The correlation of Islamic US equity has been increasingly higher from 2016 due to The Electric Power

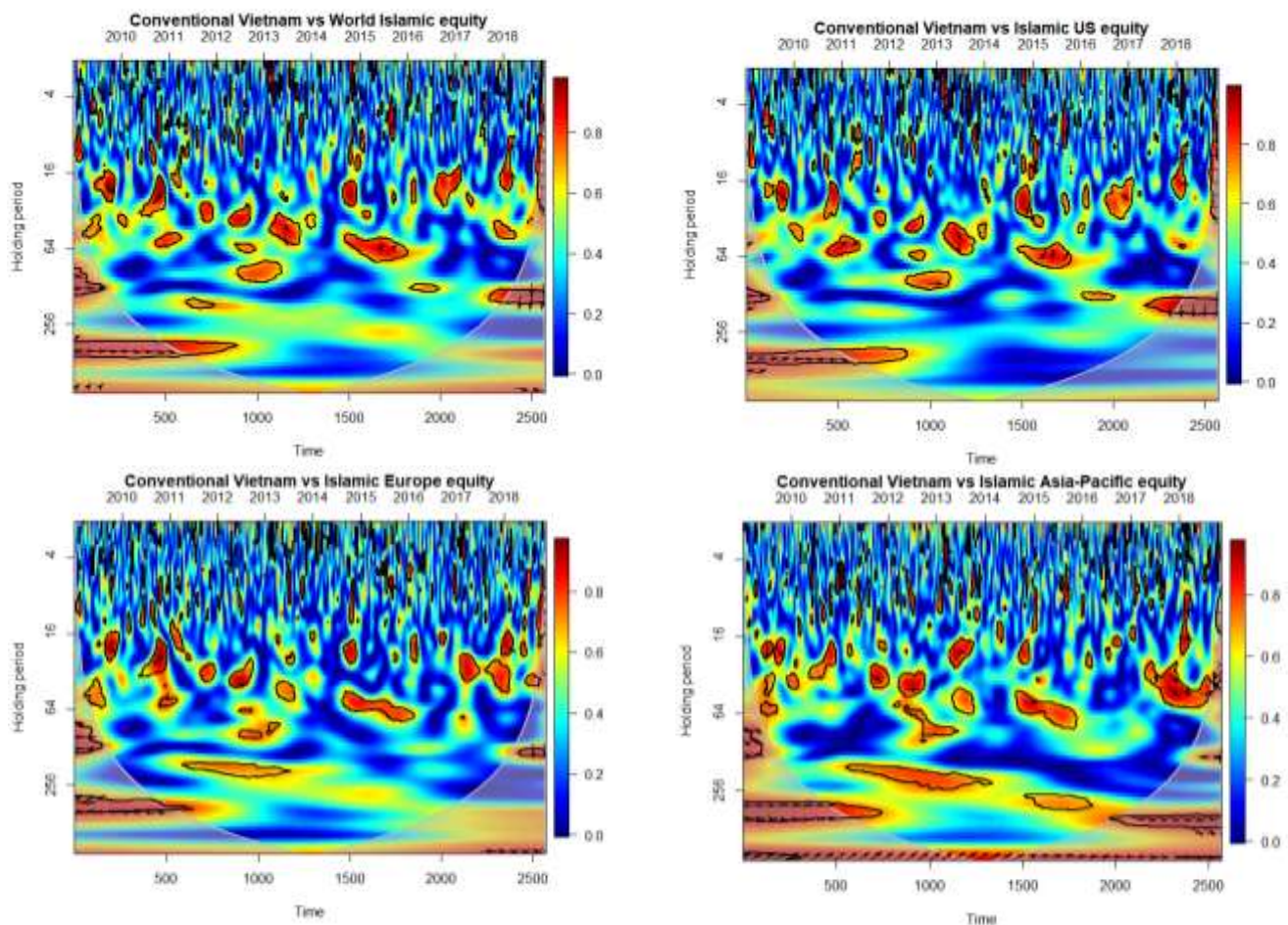
Industry Reform Act of 2001 which opened opportunities for U.S. firms to participate in the power industry in the Philippines.

Diversification benefit for Philippines is limited in Asia Pacific equity, suggesting that Philippines equity market cointegrates with Asia Pacific region to some extent. There are some diversification benefits for medium-term investors in Islamic World, US and EU. In the long-term investment, correlation is lowest in EU market, presenting opportunity for long-term investors.

Conventional Vietnam equity and all Islamic equities

From Figure 9, for less-than 16 days investment period (very-short-term), Conventional Vietnamese investors have diversification benefit in all Islamic markets. Similarly, for 16-64 days holding period (short-term), diversification benefit can be seen in all Islamic regions. For 64-256 period (medium-term), diversification benefit is observed in all markets but is more evident in Asia Pacific. For over 256 days holding period (long-term), the diversification benefit is the most evident in Islamic US equity.

Figure 9: Wavelet coherence of conventional Vietnam with Islamic World equity, Islamic US equity, Islamic Europe equity and Islamic Asia-Pacific equity.



The outstanding finding is low cointegration between Vietnam equity market with any of Islamic equity regions. This is because Vietnam equity market is relatively new and has been gradually improving to reach its neighbor countries. The Vietnamese companies are mainly domestic with limited outside exposure. Vietnam's economy expand gradually from an extremely low base, as it suffered the crippling effect of the Vietnam War, as well as the austerity measures introduced in its aftermath. Therefore, Vietnamese investors have substantial diversification opportunity in both short-term and long-term in all Islamic markets.

5. Conclusions and implications

As international diversification is still inconclusive from previous literature, this paper provides another evidence of international diversification opportunity between conventional Southeast Asian equity and Islamic equity in World, US, EU and Asia Pacific. We specifically examine Islamic stocks to further provide evidence of diversification benefit of Islamic stocks because previous literature also finds that value added of Islamic equity is mixed. By using relatively recent techniques MGARCH-DCC and Wavelet coherence, our paper would provide robust results for investors.

For the whole Southeast Asia region, we find that correlation between Asia Pacific Islamic stocks and the conventional Southeast Asian stocks is very high, implying that regional equity market integration is substantial and diversification potential is hardly observed in all holding periods. Islamic World, US and EU indices provide diversification benefit in the short-term and long-term investment. However, in the medium-term investment, diversification is limited. This implies that investors who have exposure to conventional Southeast Asian equity should focus in short-term and long-term investment in Islamic World, US and EU indices but they should avoid investment in Islamic Asia Pacific in all holding periods.

For each Southeast Asian country, international diversification benefit of Islamic stocks varies in each country. One extreme case is Singapore, where diversification benefit for medium-term and long-term investment is scant, implying that Singaporean investors should invest for Islamic stocks only in the short-term. The long-term diversification benefit is present only in Islamic Europe. The opposite of Singapore is Vietnam where diversification benefit of Islamic stocks is significantly high and can be observed in all holding periods, indicating that Vietnamese equity investors could gain from Islamic stocks in all holding periods.

For Thailand, Malaysia, Indonesia and Philippines, diversification benefit of Islamic indices vary in different holding periods as certain event could cause lower diversification potential in many periods. Financial crisis and its aftermath in 2008, for example, contribute to a higher correlation of Islamic equity and reducing diversification benefit. Thus, investors are avoided to invest during financial crisis period. In addition, since Islamic Asia Pacific equity provides less diversification benefit to these Southeast Asian countries, investors are recommended to invest in Islamic World, US and EU indices.

For the very short-term investment, Islamic equity has diversification benefit to all countries. For short-term investment, Indonesian investors has diversification benefit in all Islamic indices but Asia Pacific. However, investors in Philippines, Singapore, Malaysia and Thailand are suggested not to invest in short-term due to high correlations. For medium-term investment, Indonesia has relatively highest diversification benefit in Islamic Europe equity while Malaysia has in Islamic US. Investors in Thailand, Singapore and Philippines should avoid this investment period. For the long-term investment, Islamic equity provide relatively higher diversification opportunity than other holding periods. Indonesia, Thailand and Malaysia have substantial diversification benefit in Islamic World, Europe and US indices. Vietnam has in all Islamic indices. Philippines and Singapore have highest diversification benefit in Islamic Europe.

Our finding shows that diversification benefit of Islamic equity exists and is substantial. This is because Islamic stock indices substantial diversification benefits as Islamic equity has the limit of interest-based leverage would lead to lower systemic risks of Islamic stocks indices. Importantly, our finding shows that investing in Islamic equity yields the highest benefit for long-term investment. This finding supports one of main idea of Islamic finance in risk-sharing equity-based investment. According to Islamic investing principle, the nature of risk-sharing investment would yield the maximum benefit when investment purpose is for long-term such Musharakah and Mudarabah contracts in which contract would normally last at least more than one year. In addition, our result supports the ideal Islamic finance in which Islamic finance institutions act as venture capital by promoting long-term equity investment in small, early-stage, emerging firms that are deemed to have high growth potential. These firms will realize substantial profit and diversification benefit in a longer term after they grow and establish their competitive positions in the market. Thus, our finding of long-term substantial diversification benefit of Islamic equity is in line with the nature of Islamic equity investment.

Our policy implication is that since diversification is obvious in US and Europe region, regulators in each Southeast Asian country could promote its investors to do cross-border equity transactions in these developed regions. Security Commissions in many Southeast Asian could relax strict regulations in cross-border trading. For example, they could encourage lower and middle-income classes to invest more in international market instead of allowing only high net worth investors. This could be implemented by lowering minimum net worth requirement of investors to purchase foreign equity. In addition, commissions could facilitate cross-border listing of foreign companies in their own stock exchange by relaxing strict listing requirements and promote efficiency of the market to entice foreign firms.

References

- Achsani, N., Effendi, J. and Abidin, Z. (2007), Dynamic interdependence among international Islamic stock market indices: evidence from 2000-2007, *Proceedings of the International Conference of the Islamic Capital Markets*, Jakarta, Indonesia
- Agmon, T. (1972). The relations among equity markets: a study of share price co-movements in the United States, United Kingdom, Germany and Japan. *The Journal of Finance*, 27(4), 839-855.
- Aguiar-Conraria, L. and Soares, M. J. (2011). Oil and the macroeconomy: using wavelets to analyze old issues. *Empirical Economics*, 40(3), 645-655.
- Becker, K., Finnerty, J. and Gupta, M. (1990), The intertemporal relation between the US and Japanese stock markets, *Journal of Finance*, 45, 1297-1306
- Bodart, V. and Candelon, B. (2009). Evidence of interdependence and contagion using a frequency domain framework. *Emerging markets review*, 10(2), 140-150.
- Engle, R. (2002). Dynamic conditional correlation: A simple class of multivariate generalized autoregressive conditional heteroskedasticity models. *Journal of Business & Economic Statistics*, 20(3), 339-350.
- Grinsted, A., Moore, J. C., & Jevrejeva, S. (2004). Application of the cross wavelet transform and wavelet coherence to geophysical time series. *Nonlinear processes in geophysics*, 11(5/6), 561-566.

Kearney, C., and Lucey, B. M. (2004). International equity market integration: Theory, evidence and implications. *International Review of Financial Analysis*, 13(5), 571-583.

Solnik, B. (1974), Why not diversify internationally?, *Financial Analyst Journal*, 30 (4), 48–54.